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OCCURRENCE, ABUNDANCE, AND BIOLOGY OF THE BLACKNOSE SHARK, *Carcharhinus acronotus* IN NORTH CAROLINA

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ABSTRACT: The biology of the blacknose shark, *Carcharhinus acronotus*, is presented for specimens captured by longlining off Shackleford Banks, North Carolina between 1973 and 1982. This entails comments on the number, seasonality, catch rate, color, age, growth, size, maturity, meristics, morphology, reproduction and parasites. *C. acronotus* frequents North Carolina coastal waters from May to October. Males dominate catches through July; females from August to early fall catches. Catches varied among years and were probably afffected by seasonal water temperatures and salinity variations. Best longline catches occur on morning ebb tides and are depth specific at one depth rather than between depths. Catch per unit effort data indicate more blacknose sharks are caught/100 hooks in North Carolina than in Florida or the Gulf of Mexico; areas previously believed to harbor abundant populations of blacknose sharks.

Vertebrae were aged following staining with a modified silver nitrate technique. A linear relationship was found between vertebral radius and shark fork length. Growth curves were constructed from back calculations developed from linear regression and von Bertalanffy equations. The largest male (1,640 mm TL) and female (1,540 mm TL) *C. acronotus* taken were larger than any previously reported. Near term embryos are about 510 mm TL. Smallest free living males were encountered at 556 mm FL (684 mm TL) and 715 mm FL (877 mm TL) for females. Von Bertalanffy plots predicted 1,640 mm TL males to be 9.6 yr old. Morphometric and meristic data are given for blacknose sharks 65 to 1,400 mm TL. Teeth and vertebral counts were within ranges reported by others. Developing young 65 to 125 mm TL lack dermal denticles. Specimens 200 mm TL or larger are completely covered with pedunculate three ridged denticles. *C. acronotus* was a new host for three of the five species of parasites found on adult specimens.

Arguments are presented that indicate two breeding and pupping populations; one off North Carolina, the other off Florida and the Gulf of Mexico. A constant exchange of blacknose sharks seems to occur between these two populations and areas. The gestation period is believed to be only nine months.

Carcharhinus acronotus, the blacknose shark, characterized by a black smudge at the tip of the snout, is one of the smaller members of the 25 to 32 species of *Carcharhinus* (Compagno, 1979; Garrick, 1982). The species is believed to attain a total length of 1,370 mm (Garrick, 1982). It occurs in the western Atlantic from North Carolina southward throughout the Great and Little Bahama Banks, Caribbean, west in the Gulf of Mexico to Louisiana, British Guiana and along the South American coast from Venezuela to off Rio de Janiero (Garrick, 1982). *C. acronotus* is a nearshore species that is not abundant (Dahlberg and Heard, 1969; Bearden, 1965a, b; Clark and von Schmidt, 1965; Branstetter, 1981; Rivas and McClellan, 1982) other than on the west coast of Florida off Tampa (Springer and Woodburn, 1960), Englewood, Florida (Springer, 1938), and off North Carolina.

The biology of the blacknose shark is relatively incomplete, even though various aspects of seasonality, size, catch per unit of effort, etc. are reported for Florida and Gulf of Mexico specimens by Springer (1938), Clark and von Schmidt (1965), Dodrill (1977) and Branstetter

(1981). I present data on the number, seasonality, catch rate, age, growth, size, meristics, reproduction, morphology and parasites of the blacknose shark captured from 1973 through 1982 by longline off Shackleford Banks, Carteret County, North Carolina.

Previous Occurrence in North Carolina

Gudger (1913) and Coles (1915) referred to a 900 mm specimen from North Carolina. Radcliffe (1913) reported another captured in 1912. Coles (1915) after fishing the Cape Lookout area for 14 years caught only six more specimens in 1914. Radcliffe (1916) noted the teeth and measurements of a 1,340 mm TL female caught in the surf on Shackleford Banks 9 August 1916, and Smith (1916) cited the same specimen. Hildebrand (1941) reported a 930 mm TL specimen (male, according to Gudger's field notes) trawled in the short Newport River estuary, Carteret County (just north of Morehead City), 23 August 1930 and considered the species rare. Fowler (1945) cited a 508 mm specimen as *Eulamia acronotus* (captured off Pivers Island, Beaufort, N. C. 10 August 1936); whereas the 2,400 mm (112.5 kg) specimen he attributed to Beaufort, N. C. 16 August 1936 undoubtedly was not *C. acronotus*. August salinities for both Newport River localities usually range 28 to 32 ppt (Schwartz and Chestnut, 1973). Schwartz *et al.* (1982) reported estuarine penetrations, probably during periods of high saline water intrusions from the nearby ocean off Oak Island, North Carolina, where water temperatures ranged 23 to 29°C, salinities 15 to 22 ppt and oxygen 3.2 to 7.4 ppm. Only one other low saline penetration by *C. acronotus* is known: Pine Island Sound, Florida, 12 June 1982 (J. Casey, pers. comm.).

The 495 mm TL specimen cited by Garrick (1982) as ZSZM 8190 (now ZSZM 10180) with the date 23 December 1899 is a Florida specimen and not one from North Carolina. Information supplied by Drs. Stehman and Krafft (pers. comm.) of the Hamburg Zoologisches Museum substantiates that that specimen had apparently been bought by Brimley and the December date was either the purchase date or the date of arrival at the Hamburg Museum, as it and several other fishes are so dated and labelled. No other recent specimens have been reported from North Carolina other than by Schwartz (1979), Schwartz *et al.* (1982) and this study.

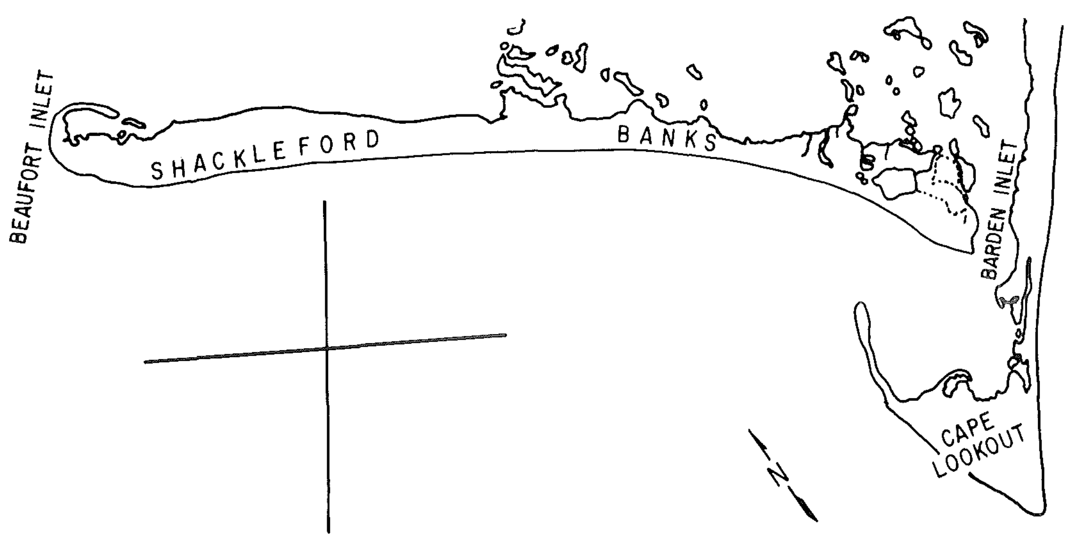

Figure 1. Shark longline sites off Shackleford Banks, North Carolina.

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METHODS

The 664 blacknose sharks studied were captured from May to November 1973 through 1982 in the Atlantic Ocean, in an area 1.0 to 3.5 km south of Shackleford Banks and 4.0 to 6.5 km east of Beaufort Inlet, North Carolina (Figure 1). All sharks were caught on unanchored 4.8 km longlines of 7.6 mm braided nylon which were fished bi-weekly in depths of 9 to 18 m from the 14.3 m R/V Machapunga. Drop lines of No. 2 chain, 1.8 m long, were snapped onto the marked mainline at either 9.1 or 13.7 m intervals, depending on whether the line was to be fished high or low in the water column. Hooks were No. 9 Mustad tuna hooks. Orange plastic floats (1.5 m diameter) were attached to the mainline every 10 hooks to help suspend the line and keep it off the sand-silt substrate. Two sets of 100 (early years of sampling) or 200 hooks were made each sample day, one east-west, the other north-south, to note capture with depth, tide and time of day. Bait was whole fresh fish trawled nearby. Duration of set for the line varied between two hours for spring and fall sets to one hour during June-September sets, when waters were the warmest. Overall yearly longline operations extended from about 15 April to 1 December, depending on extent of favorable spring or fall weather and water temperatures. Water temperatures (°C), sea state, and salinity were usually noted.

Live blacknose sharks were measured (fork length, FL) tagged on the dorsal fin with monel strap, Peterson disk or Floy dart tags and released for migration studies. Dead specimens were measured (FL or total length, TL), and females were examined for embryos and for their state of pregnancy. Weights were not taken at sea because few balances will function properly on a tossing vessel. Likewise work-space limitations and danger from large active live specimens were not conducive to personal safety, let alone weighing.

A section of vertebral column was excised from dead specimens directly below the dorsal fin and cleaned. Freshly excised vertebrae were separated with a sharp knife by cutting the intervertebral junction separating two adjacent vertebral centra. Vertebrae of small specimens were readily separated by simply bending the vertebral column until the junctions broke apart. All vertebra were then air dried under an incandescent 60-W lamp for several days for later use in aging. Dried vertebrae from extremely large sharks were often more difficult to separate and usually necessitated carefully cutting the intervertebral junction with a saw until bending or rupture separation became possible. The remainder of the carcass was processed for food, fin and body collagen studies, etc.

Dried vertebrae were aged following cleaning with clorox, sodium hypochlorite (Schwartz and Avent, 1981; Schwartz, 1983; and as modified herein). While fresh or long-term dried vertebra were equally stainable, no vertebra was used that had been exposed to formalin or alcohol. Vertebra, however, that had been preserved in formalin and stored in 70% isopropyl alcohol for as long as three months, even though they exhibit distinct rings, should be used cautiously or not at all.

Following cleaning of the superficial centrum fascia for 30 min, each vertebra was stained for 1 to 3 min (Schwartz, 1983a) in 1% silver nitrate (Stevens, 1975), 0.01% crystal violet (Johnson, 1979) or Rose Bengal. Rose Bengal stained the vertebra reddish and was not acceptable, as even momentary exposure to the stain produced highly variable results. Crystal violet was used only if problems of ring (annulus) interpretation occured following vertebral staining in silver nitrate. Best results with crystal violet occurred if the stain was dropped onto the concave surface or end of the vertebra for only 2 to 3 sec followed by prompt rinsing in distilled water, omitting the alcohol soak.

Modifications to the silver nitrate stain of Stevens (1975) are: clean the vertebra in clorox (better than generic bleach) for 30 min, treat in acetic acid for 5 min, rinse well in distilled water, and air-dry the vertebra. Care should be taken during the 1 to 3 min exposure of the vertebral end face to silver nitrate, when a 4-w UV light is held over the vertebra for 30 sec or less, to note the intensity of the stain during this period, otherwise a completely dark brown color will ensue. Following a rinse in distilled water, drop a 5% sodium thiosulfate solution onto the stained surface for 30 sec or less, then air-dry. Destaining is possible in Kodak Farmers reducer, but was not attempted.

Vertebrae were examined with a Bausch and Lomb dissecting scope under 0.7x magnification and overhead illumination, on a dark background. Measurements were made of the centrum face with a calibrated ocular micrometer. The centrum face was lying flat on the microscope stage. Growth rings (annuli) appeared as opaque and transparent zones. Radii distances were measured horizontally from the focus to the outer edge of each visible stained ring and centrum. Growth rings were best discerned immediately following staining. Immersion in water or glycerine did not enhance intensity. Supplemental thinly stained rings often appeared between wider rings considered true rings (annuli). More will be said on this feature later. Each vertebra was read twice. Vertebrae were omitted from the sample when agreement between readings could not be reached.

The relationship of vertebral radius to fork length data was best described by the formula $y = a + bx$, where x was vertebral radius (in millimeters) and y was shark fork length (mm). Substitution of focus to each growth ring distance into the formula permitted back calculation of shark fork length at each inferred earlier age.

Growth curves were also constructed from back calculated data using the von Bertalanffy (1938) growth equation: $L_t = L_\infty (1\text{-}e^{-K(1-t_0)})$ where L_∞ is the maximum size, K is rate at which length approaches L_∞ and t_0 is the hypothetical time a fish would have been zero size if it had grown according to the formula.

Fork length was also convertible to total length by a linear expression $y = a + bx$ where $x =$ fork length (mm) and $y =$ total length (mm). This was necessary when comparing or converting literature cited total lengths to fork lengths.

Stomachs of most longlined blacknose sharks were empty or contained the bait used to capture them, hence no observations on food are given in this report. However, spiral valves of 10 specimens were examined for parasites.

RESULTS AND DISCUSSION

Environmental Conditions

Study site sea water temperatures (recorded 2 m below the surface) varied from 10°C in April to 32°C in August (usual range 12 to 30°C). Salinities (at similar depths) usually ranged 28 to 34 ppt, with highs occurring in November and lows in April. The sampling area salinity was also often influenced by

Table 1. Number and length of males (M), females (F), no sex (NS), and lost (L) blacknose sharks, *Carcharhinus acronotus*, captured monthly longlining during years 1973 through 1982 in the Atlantic Ocean south of Shackleford Banks, North Carolina.

Fork Length (FL) mm

Year/Month	701-750*		751-800		801-850		851-900		901-950			951-1000			1001-1050			1051-1100			1101-1150			1151-1200			1201-1250			1251-1300			1301-1350		1351-1400		Total/Month				Total/Year
	M	F	M	F	M	F	M	F	M	(NS)	F	M	(NS)	F	M	(NS)	F	M	(NS)	F	M	(NS)	F	M	(NS)	F	M	(NS)	F	M	(NS)	F	M	F	M	F	M	(NS)	F	(L)	
1973 - Ju						1		1		(2)		1	(4)		2	(1)	1	1	(1)					1	(1)			(2)			(1)						5	(12)	2		
S																													2										2		
O												1					1											(3)					1				2	(3)	1		27
1974 - Jn																				1																			1		
Ju												1									1			1													3				
S																						(1)			(1)								1		1		2	(2)			8
1975 - M									1																												1				
Jn					3	1	2	3	5		8	2		2	4		1			1			1			2						1					16		20		
Ju									1		1	3		1			1						1														4		4		
S					1	1		3	1		3			1			1			1						1											2		11		58
1976 - Jn							3	1	2			2			2			1			1																11		1	(1)	
Ju			1	2	2			1			1	1					2									1											4		7	(1)	
A						1		1			1												2																5		
S									1								2			1																	1		3		
O											1	1		3			1																				1		5		40
1977 - M	1	2	1															1		2			1														3		5	(1)	
Jn					2	1	2	1			1	2					2									1											6		6		
Ju		2							1			1			4		1	2																			8		3		
A									2		4	2		6			12			16			4			9									1		5		51	(2)	
S					1						2	2		1	3		3	2		9	1		8			5				1		1					10		29		
O									1			1					2			1			2			3											1		8		138
1978 - M						1	1				2	2			2			2		1																	7		4	(1)	
Jn							1		3			2		1			2	3																			9		3		
Ju									1					1	1					1			2														2		4		
A					1		2		1		5	4			3		2	1		2			2														12		11	(2)	
S		1						2	2			1		2				1		2			2						1				1				5		10		
O									3																												3				73
1979 - M															2		1	1					1														3		2		
Ju						1	1	1	1		4	5		3	2		3			4						1											10		17		
A									1		2	4		6	1		4			3			1														6		16		
S									3		1	1		1	1		5						4			3			1								5		15	(2)	76
1980 - Jn												1											1														1		1		
Ju					2		3		2		2	14		9	1		2	5		5	1						1										30		18		
A									3			1		3	3		1			4	1								1								8		9	(1)	
S		1			2			2	5		1	1		3			17			10			8			3						1					8		46		122
1981 - Jn							1				1	3			1		1			2						1											5		5		
Ju															3					3			3			1			2			1					3		10		
A					1		1		1					1			1	1																			4		2	(1)	
S																							1																1		31
1982 - M									1			1			3		1	1																			6		1		
Jn							1							1																							1		1		
Ju			1		4	1	1	1			5			1	1																						7		8	(9)	
A				1	4		9	10	1		1	5			1		2	5		10									1								25		25	(1)	
S					1	1									1																						2		1	(1)	
O											1	1														1											1		2		91
Total*	1	6	3	3	24	9	28	27	43	(2)	47	66	(4)	46	40	(1)	72	27	(1)	44	5	(1)	79	2	(2)	32	1	(5)	8	1	(1)	4	3	0	2	0	247	(17)	376	(23)	664

*Captured only one specimen less than 701 mm: male 556 mm FL, July 1979.

influxes of sound waters that had passed out nearby Barden (12.8 km to the east) or Beaufort Inlet (Figure 1). Prevailing winds were usually from the southwest. Longshore currents were east-west. Strong southeasterly winds in August also drove Gulf Stream waters onto the capture site.

Seasonality

Originally, I believed *C. acronotus* occurred in North Carolina's inshore waters from June to August (Schwartz, 1979) in depths to 34 m (Dodrill, 1977, states it is caught to 38 m in Florida). Longlining off Shackleford Banks from 1973 through 1982 now permits me to extend that period to May through October (Table 1). Most blacknose sharks were captured during longline sets in August, July, and September (186, 172, 158 sharks, respectively, Table 1). Blacknose sharks usually appeared off Shackleford Banks as early as 20 May and remained as late as 23 October. Males were more common in the catches until July: females dominated the August and early fall catches (Table 1). Large females were the last to leave North Carolina waters. Springer (1938), Clark and von Schmidt (1965) and Dodrill (1977) found May to be the month of greatest abundance for blacknose sharks in Florida, while Branstetter (1981) noted captures in the Gulf of Mexico from May through mid-November.

Captures in Present Study

Capture of only 27 blacknose sharks in 1973 (Table 1) was probably influenced by low salinity conditions that persisted into 1973 off Shackleford Banks and in local estuaries following the late summer 1972 hurricane Agnes. Low catches of 8 and 58 sharks in 1974 and 1975 were not explainable in terms of salinity as those years were low runoff years and high salinities prevailed during the prime capture period. Locally the winters of 1976 and 1977 were the coldest on record, yet, with normal rebounding water temperatures during the following spring and summer, only 40 sharks were caught in 1976 as compared to 138 in 1977. Basically 1976, 1977 and 1980 were also drought years; 1978 was a high rain runoff year. A prolonged period of extreme daily high air (±35°C) and water temperatures (±31°C) prevailed in July-August 1980, causing drastic inshore populational changes and movements of the sharks off Shackleford Banks, in response to the high water temperatures and a conspicuous absence of prey.

Water temperatures warmed slowly until July in 1981 and were usually three weeks behind those expected, conditions that could explain the poor (31) blacknose shark catch that year. The same water temperature pattern existed in 1982 yet a catch of 91 was recorded. For the present, much of the erratic nature of the catches must go unexplained as there seems to be no relationship between catch and environmental parameter (see also CPUE section).

Color

Springer (1938) and Bigelow and Schroeder (1948) alluded to two color phases for *C. acronotus.* Most were cream-olive above and white below without definite fin markings. Other specimens were uniform brown. Garrick (1982) noted color after preservation as gray or grayish-brown above, white to cream below; apex of second dorsal fin dusky or with black margin; margin of caudal fin or lower lobe black edged or dusky; trailing edges of first dorsal, pectoral and pelvic fins pale or white; snout tip dusky to black, not always obvious.

All free-living blacknose sharks in North Carolina, except for those caught in October, are lemon colored dorsally and white ventrally and are often mistakenly called lemon sharks. Fresh caught specimens also exhibit an elongated whitish "Z" on their sides that originates at the pelvic fins and projects forward toward the pectoral fins, similar to that I noted for finetooth (*C. isodon*), blacktip (*C. limbatus*) and spinner (*C. brevipinna*) sharks (Schwartz, 1979). Fin edges, except for the rear of the pectoral fins, may be dusky. The rear of the pectoral fins have a white edge similar to the Atlantic sharpnose shark. *Rhizoprionodon terraenovae* or smooth dogfish, *Mustelus canis*. Newly pupped specimens have a dusky second dorsal fin edge. The dusky or black snout appears early in gestation (<151 mm TL) (UNC 15552).

Body color of developing specimens <120 mm TL is cream throughout. The entire body is gray in unborn specimens of 249 to 371 mm TL, whereas larger unborn specimens are gray above, white below. They also possess light whitish areas on all fins, the precaudal pit, around the eyes, the base of the pelvic fins, the tips of the claspers, the area around the tip of the snout and anterior to the umbilical cord but not on the ventral surface of the head. The sides of the head anterior to the pelvic fins and up as high as the top of the gill slits are whitish. Unborn specimens of about 500 mm TL have a black edge on the caudal fin that disappears in term specimens. Further comments on the embryology of the blacknose shark will be discussed in another paper.

Fall (September through November) caught adults are gray dorsally, white ventrally and often possess gray spots scattered on the sides of the body, especially when caught in waters near 10 °C. Occasionally late fall specimens have a bronze coloration that overlaps the gray.

Shape

Developing young 80 to 120 mm TL have a wide triangular head with an inferior mouth (UNC 16046, Table 2) and are shaped like adults. Gill trophonemata of 2 to 4 mm are evident in these specimens and attain lengths of 11 mm in September embryos of 156 mm TL, (UNC 15552, Table 2). Trophonemata regress in specimens larger than 156 mm TL and are not evident in developing specimens 165 to 175 mm TL (Table 2). Specimens 151 to 510 mm TL (UNC 15552 or 16082, Table 2) have the outer edges of the first dorsal, upper and lower caudal fins strongly arched and curved although these features may be absent in specimens larger than 480 mm TL.

Dermal denticles are lacking in young blacknose sharks 65-125 mm TL. The skin is smooth and readily sloughed with handling. Specimens 200 mm TL or larger are completely covered by flat spade-shaped denticles nearly 0.4 mm square; one small rearward projecting point is evident on each denticle. No pedicel is evident. Each denticle is separated from its neighbor by at least 0.5 mm. Near term and all free-swimming blacknose sharks have pediculate denticles with three ridges and rear projecting points, in agreement with Bigelow and Schroeder (1948) and Garrick (1982).

Deformities

Only two reports of deformities are known for the blacknose shark. Branstetter (1981) cited a 122 cm TL female with a deformed first dorsal fin in which the apex was folded over and had grown to the fin. Schwartz (1984) captured a 965 mm FL (1,193 cm TL) 9.9 kg blacknose shark 8 July 1980 in the study area that had a heavy monofilament line encircling the head at the level of the 4th gill slit; the line had apparently been sewn in, rather than being a remnant of a gill net encounter.

Parasites

Hester (1981) examined spiral valves of 10 adult blacknose sharks captured between 8 July and 16 September 1980. Although all specimens were adults he did not record sex or overall sizes. He found five species of parasites and *C. acronotus* served as a new host for three of them. Five specimens were free of parasites, two possessed *Phoreiobothrium triloculatum*, three harbored *Phoreiobothrium lasium*, and one each had *Platybothrium cervinum*, *Phyllobothrium* sp. 2 and *Acanthobothrium* sp. 4.

Teeth

Tooth counts of five young specimens, a 510 mm TL female (UNC 16082), a male 456 mm TL, 3 females 463-478 mm TL (UNC 9334) as well as adults were $\frac{12\text{-}1\text{-}12}{11\text{-}1\text{-}11}$ and agreed with those noted by Springer (1938), Bigelow and Schoreder (1948), and Garrick (1982). X-rayed uteri revealed that developing specimens of at least 200 mm TL had minute teeth in each jaw.

Table 2. *Carcharhinus acronotus* captured in North Carolina 1973-1980, proportional dimensions in percentage of total length. * = visible, $\bar{s}$ = smudge.

Specimens	UNC 16046							UNC 15552				UNC 15551	
	1	2	3	4	5	6	7	1	2	3	4	1	2
Total length (mm)	82.5	80.8	120.7	117.2	109.8	80.6	84.55	156.7	158.5	160.9	151.8	170.1	173.7
Fork length (mm)	70.9	68.05	98.0	98.7	89.0	65.6	70.6	126.0	121.2	130.4	124.4	134.5	137.7
Weight (g)	3.6	3.8	7.6	7.8	5.8	3.8	3.9	26.0	26.7	26.1	24.3	31.7g	32.8
Sex	♂	♀	♂	♂	♀	♀	♂	♀	♀	♀	♀	♂	♀
Snout to													
outer nostrils	4.1	4.3	4.3	4.3	4.1	5.0	4.6	6.1	4.7	4.0	5.2	5.3	5.4
eye	7.6	8.2	8.0	7.6	7.8	9.3	8.4	9.6	8.2	8.5	7.9	8.2	7.8
mouth	9.1	10.8	9.6	9.4	8.9	10.5	10.5	9.1	8.8	9.3	9.2	8.9	8.9
1st gill opening	22.7	24.3	22.5	22.1	23.2	24.9	22.2	21.1	19.5	19.2	21.4	20.3	20.1
3rd "	26.7	27.2	25.4	24.3	25.0	25.7	24.8	23.9	24.0	25.2	24.6	23.3	24.1
5th "	28.0	29.8	27.9	27.0	28.2	27.3	29.0	26.8	26.9	26.9	26.4	25.3	25.8
pectoral origin	26.2	27.9	26.6	27.3	26.5	26.7	27.9	25.2	25.1	24.7	25.8	23.7	23.7
pelvic origin	50.4	50.7	45.6	48.7	46.5	50.0	49.7	49.7	50.8	50.2	51.4	47.4	45.3
1st dorsal origin	38.2	39.2	34.8	35.2	34.6	37.4	35.2	35.2	36.0	35.6	36.6	34.6	35.6
2nd dorsal origin	66.5	66.1	62.3	64.0	61.7	63.4	63.3	62.9	62.5	64.1	61.6	60.0	59.9
anal fin origin	64.1	60.9	58.8	62.3	59.1	62.5	61.3	61.4	62.1	60.9	61.1	60.0	59.9
upper caudal origin	77.1	78.0	73.7	75.1	74.8	75.3	76.0	73.1	73.5	72.3	73.5	70.8	70.6
lower caudal origin	76.8	76.9	73.3	75.1	73.8	74.5	76.0	72.8	73.6	72.6	73.5	70.8	69.5
Nostrils													
distance between inner corners	8.6	8.5	6.5	7.1	-	7.8	6.4	6.3	6.1	6.4	6.4	5.6	5.9
Mouth													
width	12.8	10.3	9.2	9.6	9.3	10.0	10.6	11.2	9.5	9.5	9.3	9.2	8.3
length	4.8	4.3	5.0	4.7	5.0	4.5	5.3	6.1	3.8	4.1	4.6	3.2	4.3
Labial furrow lengths													
upper	-	-	-	-	-	-	-	-	-	0.9	1.3	-	-
lower	-	-	-	-	-	-	-	-	-	-	-	-	-
Gill opening lengths													
1st	4.2	4.4	2.6	2.6	2.1	2.5	2.7	3.9	3.4	2.8	3.7	3.5	3.8
3rd	5.6	4.5	2.6	2.6	2.7	3.1	3.1	3.9	3.8	3.4	4.1	3.8	3.8
5th	4.4	4.3	2.5	2.1	2.7	3.0	2.6	3.5	3.2	2.8	3.6	3.6	2.6
Eye													
horizontal diameter	6.1	5.7	5.7	5.6	5.6	6.1	6.5	4.0	4.1	4.0	4.2	4.3	3.9
1st dorsal fin													
length of base	9.1	8.7	9.6	9.0	8.5	8.4	8.2	9.4	10.1	9.1	9.2	9.2	9.5
length of posterior margin	2.1	2.7	3.3	3.8	3.7	2.9	3.0	2.8	2.7	3.1	3.2	3.3	2.7
height	6.1	6.8	6.2	6.0	6.0	5.5	5.0	6.8	6.7	6.9	7.0	8.3	6.3
2nd dorsal fin													
length of base	3.9	4.2	4.3	3.3	3.7	3.7	3.5	4.1	4.2	4.2	4.1	3.8	3.9
length of posterior margin	2.2	2.7	3.0	4.0	3.3	3.5	3.5	3.8	3.8	2.8	3.1	3.1	2.9
height	2.2	2.7	1.9	2.3	2.8	2.5	3.0	2.4	3.1	1.6	2.5	3.0	2.8
Anal fin													
length of base	6.1	6.5	5.6	6.1	5.9	5.8	5.9	5.0	4.7	3.4	5.7	4.4	4.3
length of posterior margin	2.6	2.2	4.1	3.8	3.3	3.5	3.0	2.4	3.0	3.2	3.8	3.2	2.6
greatest width	3.0	3.8	2.5	3.0	2.8	2.6	1.8	3.1	3.0	3.4	3.3	3.2	3.3
Pectoral fin													
length of base	5.0	5.6	5.1	5.2	5.1	5.6	6.0	5.6	5.4	5.0	5.3	5.2	5.2
length anterior margin	9.3	9.3	11.6	11.9	10.9	8.9	10.2	10.9	11.9	12.4	13.7	12.3	12.4
length distal margin	8.5	7.5	8.7	9.0	8.2	7.8	8.2	10.4	9.5	10.3	9.1	9.7	9.8
greatest width	8.4	7.5	8.7	9.0	9.1	7.8	7.7	10.2	10.5	10.6	9.0	10.6	10.7
Pelvic fin													
length of base	3.6	4.2	3.5	4.4	3.8	4.3	3.1	3.6	3.5	3.5	3.7	3.5	3.7
length anterior margin	4.8	4.2	5.5	5.5	4.1	5.2	4.3	4.5	5.4	5.3	5.0	5.2	5.4
length distal margin	4.3	5.0	4.2	4.4	-	4.7	4.0	5.1	4.8	5.0	4.6	5.1	5.0
length of claspers	2.8	-	2.6	2.9	2.5	-	3.9	-	-	-	-	2.4	-
Caudal fin													
length of upper lobe	23.8	24.0	26.3	26.5	31.2	23.4	27.2	26.5	26.8	26.6	26.5	26.5	27.3
length of lower lobe	5.7	6.9	9.4	9.3	5.9	8.1	7.5	8.6	9.4	9.0	10.0	8.4	8.6
Trunk at pectoral origin													
width	14.1	13.0	10.4	12.4	12.4	13.8	11.0	13.5	13.6	13.4	14.2	12.6	13.0
length	1.8	11.8	10.4	11.3	10.7	12.4	11.6	14.2	12.7	13.0	13.2	13.5	13.3
Vertebra													
precaudal	-	-	-	-	-	-	-	77	83	85	84	87	85
caudal	-	-	-	-	-	-	-	71*	74*	75*	76*	82	74*
total	-	-	-	-	-	-	-	-	-	-		169	-
Head													
width	17.6	15.8	14.7	15.1	13.5	16.8	14.8	14.4s	15.5s	15.2	15.3	14.7	14.4
Trophotremata													
present	+	+	-	-	+	-	-	+	-	-	-	+	-
length (g)	4.0	2.1	-	-	6.0	-	-	11.2	-	-	-	9.0	-

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Table 2. cont.

	UNC 9334				UNC 16082				UNC 9936						
	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7
	456	478	463	470	501	510	495	496	453	461	484	493	489	482	487
	370	378	378	377	405	410	409	398	370	374	395	385	388	390	394
	457.0	508.2	536.3	555.9	610.4	624.1	649.9	610.8	551	586	679	647	634	638	717
	♂	♀	♀	♀	♂	♀	♀	♂ has umbilicus	♂	♀	♂	♂	♀	♀	♂
	·4.3	4.6	4.5	4.5	4.8	5.7	5.1	4.6	4.2	5.2	5.0	3.9	5.3	4.4	5.1
	7.9	8.4	9.3	8.9	8.4	8.4	8.1	8.3	8.4	7.6	7.4	7.5	7.7	8.5	7.5
	8.8	9.0	8.9	8.9	8.8	9.2	8.7	8.1	8.8	9.3	9.1	8.9	8.8	9.5	8.8
	19.7	19.5	19.7	20.9	18.9	19.4	19.8	18.3	19.4	19.3	18.6	18.5	18.8	9.5	31.8
	21.9	21.3	20.9	20.0	21.2	21.0	21.0	20.6	20.9	21.9	21.9	19.7	20.4	19.7	34.1
	24.6	23.6	23.5	21.5	23.4	24.1	22.8	22.4	24.7	23.9	24.0	22.7	22.9	21.6	36.1
	23.5	23.0	22.0	23.4	21.9	21.8	21.6	21.4	23.0	23.0	23.1	22.3	22.3	22.6	24.0
	48.0	46.0	47.9	46.8	46.7	47.3	48.3	46.4	50.6	46.6	48.8	46.7	46.8	48.7	48.9
	54.8	52.1	53.1	50.6	31.9	31.7	32.9	32.5	30.9	32.3	31.0	31.4	29.2	31.7	31.4
	84.4	80.5	83.2	82.9	62.1	61.8	64.4	61.1	61.8	62.5	61.2	59.4	60.1	61.6	61.6
	61.2	59.4	61.3	60.6	60.9	60.9	62.0	60.1	62.8	60.3	62.2	59.4	58.9	62.0	60.6
	72.4	70.5	73.2	71.9	72.9	72.5	74.1	71.8	73.1	72.0	73.3	72.0	70.8	73.2	72.2
	72.1	70.1	73.4	71.7	72.5	72.5	73.7	71.6	72.6	71.6	73.3	72.0	71.1	73.2	72.2
	5.3	5.2	5.4	5.5	5.0	4.9	5.1	5.2	5.7	5.6	5.2	5.1	5.5	5.4	5.7
	7.0	6.7	7.6	7.4	6.6	6.5	6.5	6.7	7.3	8.2	7.2	7.7	7.0	7.1	8.2
	3.5	4.3	4.5	4.5	5.0	4.7	5.3	4.8	4.9	4.8	4.1	3.9	3.7	4.6	3.7
	0.4	0.4	0.4	0.4	0.6	0.4	0.6	0.6	0.4	0.2	0.4	0.4	0.4	0.4	0.4
	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	3.3	2.5	3.0	2.8	2.6	2.5	2.2	2.2	3.1	3.5	2.5	2.8	2.2	3.3	3.3
	3.5	3.1	3.5	3.2	2.8	2.9	2.6	2.4	3.0	3.9	3.1	2.8	3.5	3.3	3.7
	2.6	2.7	2.8	2.6	2.2	3.1	2.2	1.8	2.4	2.8	2.6	2.0	2.7	2.5	3.3
	2.2	2.1	1.9	1.9	2.0	2.0	2.2	2.0	2.2	2.4	2.1	1.9	2.0	1.9	2.1
	9.4	8.6	8.9	9.1	8.4	8.8	8.8	9.3	8.8	9.1	9.3	8.8	9.4	9.5	9.0
	3.9	4.2	3.7	3.6	4.7	3.7	3.6	3.6	4.0	3.7	4.3	4.1	3.5	3.7	4.1
	7.5	6.7	7.3	7.0	6.6	6.9	6.5	7.1	8.2	6.9	6.6	7.1	7.1	6.8	7.4
	3.9	4.2	4.1	4.0	3.4	3.7	4.0	3.6	4.0	3.9	4.5	3.7	3.1	3.7	3.5
	3.5	3.8	3.9	3.2	3.8	3.5	3.2	3.2	4.0	3.9	3.9	3.9	3.9	3.5	3.9
	2.4	2.1	2.8	2.6	2.6	3.5	2.6	2.4	3.1	3.0	2.7	2.8	3.1	2.7	2.8
	4.4	5.0	4.5	4.0	4.0	4.3	4.4	4.4	4.1	4.3	4.1	3.9	4.5	4.8	4.3
	3.7	5.9	3.7	3.2	3.6	3.5	3.6	3.2	4.0	4.1	3.7	3.7	4.1	3.7	5.7
	3.5	3.6	3.2	3.0	3.2	3.1	3.0	3.4	3.5	3.3	3.3	3.4	3.9	3.7	5.7
	4.8	4.2	4.5	4.7	4.2	4.5	4.8	4.6	5.1	5.0	5.0	5.1	4.1	4.6	4.9
	14.9	14.4	14.9	14.5	14.4	13.9	13.7	14.3	15.0	15.6	15.7	15.0	14.5	14.5	15.0
	12.3	11.1	10.5	10.9	11.8	10.0	10.1	11.5	11.0	12.1	10.7	10.5	10.8	9.5	10.7
	9.9	10.3	9.3	9.4	9.0	8.8	8.7	9.5	9.9	9.1	9.1	8.9	8.8	8.5	9.0
	3.7	3.3	3.0	3.4	3.2	3.1	3.2	3.4	5.1	3.7	3.5	3.2	5.3	3.3	3.5
	5.9	5.9	6.5	6.0	5.6	5.7	5.7	5.6	5.7	5.9	5.8	5.7	5.9	5.6	6.0
	4.6	4.6	4.3	4.9	4.8	4.9	5.3	4.8	5.5	5.2	4.5	5.7	5.3	5.4	5.3
	2.6	–	–	–	2.6	–	–	2.4	2.9 2.9	–	2.4 2.4	2.6 2.6	2.9 2.7	–	–
									R L		R L	R L	R L		
	2.6	–	–	–	27.5	26.9	25.9	26.8	27.6	27.8	28.3	26.0	28.6	27.2	27.7
	27.9	27.2	27.0	28.1	10.9	10.8	10.1	10.1	11.0	10.4	11.0	10.5	10.8	10.6	11.5
	11.6	11.5	11.4	10.8	10.6	10.9	11.3	10.9	11.9	13.0	12.0	12.1	11.2	11.4	12.1
	11.4	11.3	11.7	11.3	10.8	10.9	11.3	10.3	11.9	12.8	12.6	12.1	14.1	12.9	12.5
	83	83	81	89	81	85	86	85	85	86	83	81	85	82	87
	85	87	89	85	87	87	87	85	87	86	87	87	88	83	87
	168	170	170	174	168	172	173	170	172	172	170	168	173	165	174
	12.7	12.1	12.1	12.1	10.8	11.4	11.7	12.1	–	–	–	–	–	–	–
	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=

Table 2. Continued.

29, July 1975 1	24, July 1979 2	8, July 1980 3	Oct, 1978 4	24, July 1979 5	Uncatalogued 24, July 1979 6
976	1155	1193	1205	1218	1265
807	950	965	977	977	1040
5896.8	9072.0	9979.2	9979.2	10951.2	10951.2
♂	♂	♀	♂	♂	♂
-	-	-	-	-	-
-	-	-	-	-	-
7.9	8.7	7.5	8.5	8.6	7.9
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
21.2	22.5	22.1	19.9	20.1	21.7
47.6	48.7	51.3	42.6	45.2	45.5
31.9	30.9	32.2	33.9	34.5	31.6
63.5	64.5	63.8	63.7	63.6	60.5
62.8	63.4	63.3	62.6	62.2	60.7
73.3	74.5	75.7	73.3	74.1	71.7
-	-	-	-	-	-
4.7	4.8	4.7	4.6	4.7	4.5
7.3	7.1	7.8	7.5	7.4	7.9
4.5	4.3	4.6	4.1	4.1	4.7
-	-	-	-	-	-
-	-	-	-	-	-
2.7	2.3	2.6	2.9	2.6	2.8
3.2	3.0	3.3	3.8	3.5	3.4
2.6	2.2	2.5	2.9	2.4	2.4
1.4	1.5	1.6	1.4	1.6	1.2
8.9	9.1	9.8	9.0	9.3	8.7
3.9	3.9	3.5	3.9	3.5	3.2
9.8	9.4	10.1	9.0	9.9	9.7
3.7	3.5	4.0	3.9	3.9	3.3
3.5	3.5	3.3	3.0	3.3	3.4
3.2	2.7	2.9	2.3	3.1	2.8
4.6	4.5	5.2	4.6	4.5	4.5
3.6	3.7	3.6	3.2	3.0	3.4
3.4	3.4	4.2	4.0	3.3	3.0
-	-	-	-	-	-
15.5	15.7	17.4	15.4	14.6	14.6
13.1	14.2	15.8	13.7	13.8	12.3
-	-	-	-	-	-
-	-	-	-	-	-
15.5	15.7	17.4	15.4	14.6	14.6
13.1	14.2	15.8	13.7	13.8	12.3
-	-	-	-	-	-
3.4 3.3	9.3 8.8	-	9.5 9.7	8.2 9.2	8.9 9.4
26.1	24.8	26.2	25.6	25.5	24.7
11.5	11.9	12.4	21.6	11.9	10.7
-	-	-	-	-	-
12.4	13.4	14.8	13.7	15.2	14.6
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

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Vertebrae

It was difficult to obtain a complete caudal vertebral count in specimens 83 to 127 mm TL as the vertebrae apparently were not dense enough to reflect the X-rays of the Picker Industrial Unit used. Blacknose sharks larger than 170 mm TL from North Carolina had a total vertebral count that ranged from 165 to 174 ($\bar{X}$ 170.5, n = 6), agreeing with Compagno (1979) 167 to 175 and Garrick (1982) 165 to 181 ($\bar{X}$ 171.6, n = 6). Garrick (1982) reported precaudal vertebral counts 81 to 87 ($\bar{X}$ 83.9, n = 26). Precaudal counts for North Carolina blacknose embryo sharks 151 to 161 mm TL ranged from 77 to 89 ($\bar{X}$ 83.9, n = 23); incomplete caudal vertebral counts for these embryos ranged 71 to 74 mm TL (Table 2).

Size

Springer (1938) estimated *C. acronotus* to reach a length of 140 cm. Bigelow and Schroeder (1948) stated that blacknose sharks seldom exceeded lengths of 152 to 183 cm. Clark and von Schmidt (1965) noted total lengths for the largest male and female blacknose sharks they caught near Sarasota, Florida as 117 and 126 cm, respectively. Hoese and Moore (1977) and Dahlberg (1975) claimed a 167 cm length for *C. acronotus*. Dodrill (1977) caught blacknose sharks as large as 130 cm TL in November off the lower east coast of Florida. Moore and Farmer (1981) cite a 2.4 m (TL?) maximum size for *C. acronotus*. Branstetter (1981) gave 130 cm as the maximum length for Gulf of Mexico specimens; Garrick (1982) noted 137 cm as the maximum size. Castro (1983) listed 140 cm TL as the maximum size.

In North Carolina, the smallest free-living male and female blacknose sharks were 556 mm FL (684 TL) and 715 mm FL (877 mm TL) (Table 1), captured 24 July 1979 and 30 September 1980, respectively. The largest male and female were 1,400 and 1,300 mm FL. These were captured 16 August 1977 and 12 September 1977, respectively. Fork lengths can be converted to total lengths by the formulas: males y (TL) = −10.76 + 1.25x FL and females y (TL) = 5.41 + 1.22x FL. Thus, blacknose sharks do attain maximum lengths of 1,640 and 1,540 mm TL (actual measurements, not converted measurements), sizes larger than previously reported. Using the relationship that fork length remains about 80.6% of total length in males and 81.4% in females, near term young should be about 505 mm TL. Note that the four largest near term specimens (UNC 16082, Figure 2) had actual fork lengths of 398 to 410 and total lengths of 495 to 510 mm (Table 2). Near term sizes of 495 to 510 mm TL (Table 2) are larger than that of the 45 cm TL specimens caught 6 June off Sarasota, Florida by Clark and von Schmidt (1965). Bigelow and Schroeder (1948) also reported newborn 48.5 cm TL blacknose sharks with umibilical scars. Branstetter (1981) estimated pups were born in June off Alabama at 45 to 50 cm TL for he captured a 53 cm TL juvenile 19 June. On the basis of these data (Table 1), it would appear that *C. acronotus* pups rarely occur in North Carolina. However, they are probably less prone to longline or otter trawl capture. Pups and juvenile blacknose sharks do contribute to the July-August pier or sport fishery (where smaller hooks are used) where they are confused with the Atlantic sharpnose shark. The smallest embryos from North Carolina, 80.6 mm TL, weighed 3.69 g while the largest adults weighed 10.9 kg (Table 2). The latter weight was far short of the 18.4 kg for 125.6 cm TL sharks caught by Dodrill (1977). Branstetter's largest

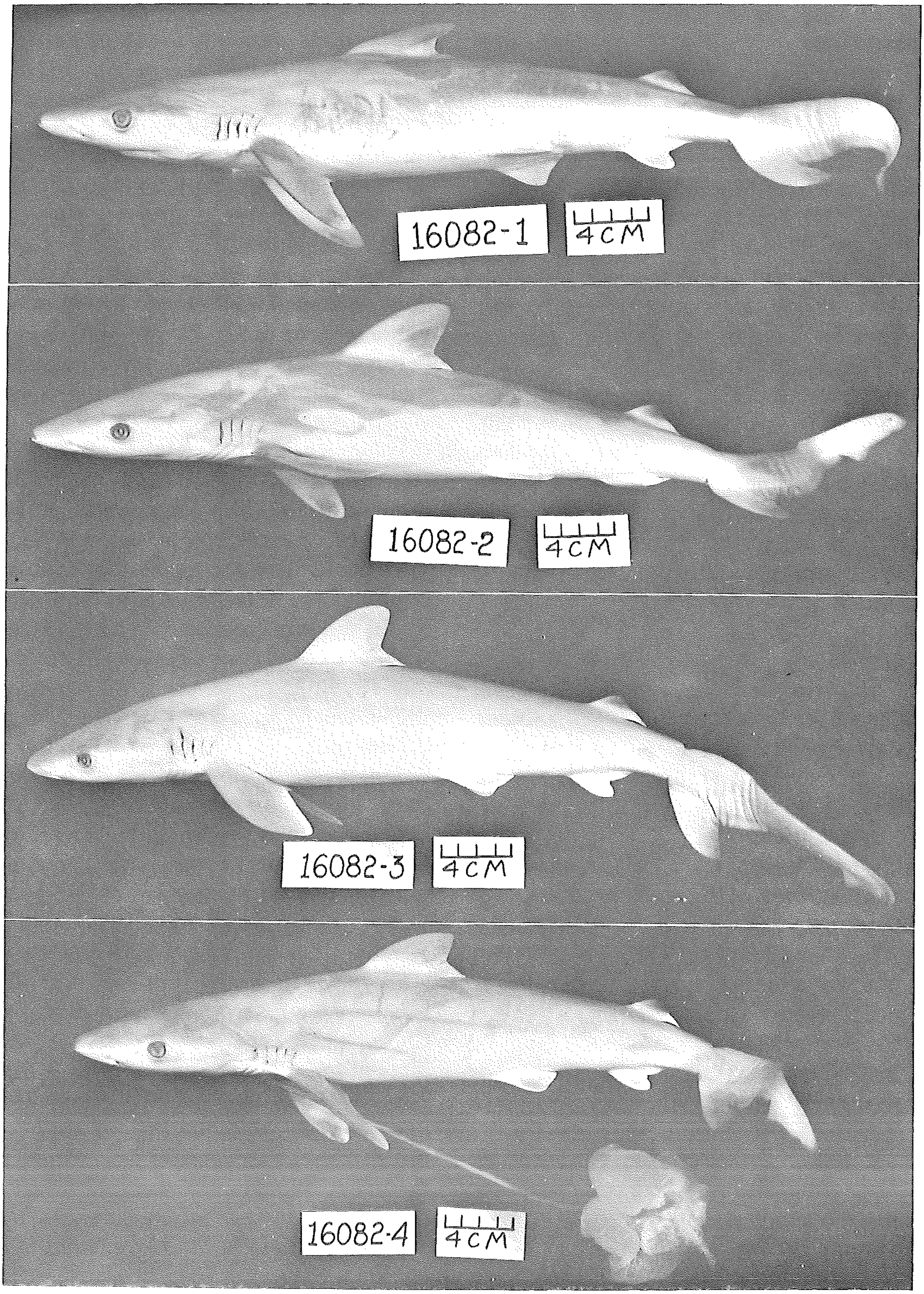

Figure 2. Near term blacknose sharks (UNC 16082) removed from a female caught off Shackleford Banks, N. C. 4 June 1981. See Table 2 for proportional data.

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specimen was 130 cm TL with those larger than 110 cm TL varying from 7 to 11 kg. Meristic and morphometric data, given in Table 2, for *C. acronotus* 80.8 to 1,265 mm TL complement and expand upon those in Garrick 1982.

Maturity

Males in North Carolina mature at 110 cm TL. This is larger than the 103 cm TL reported by Clark and Von Schmidt (1965) for Sarasota, Florida mature males or by Springer (1938), 101 cm TL, or by Dodrill (1977) 106 cm TL for other Florida specimens, yet near the 114 cm TL noted by Branstetter (1981). Castro (1983) simply stated that maturity was reached at 100 cm TL. Garrick (1982) noted a clasper length 4.7% of TL for a specimen 970 mm TL and a mature 106 cm TL male had clasper lengths 9.1% of total length. Clasper lengths (Table 2) varied from 2.4 to 3.9% TL in immature North Carolina blacknose males 82 to 1,155 mm TL and varied 8.2 to 9.7% in mature males larger than 1,155 mm TL.

Reproduction

North Carolina blacknose shark females of ~120 cm TL were carrying well advanced pups (170 mm TL) by 3 September 1980, yet other specimens of 138 cm TL, 30 September 1980, possessed small embryos and yolk. Branstetter (1981) found mature females of 113 cm TL with young, a size larger than noted (103 cm TL) by Clark and von Schmidt (1965) yet smaller than noted (124 cm TL) by Dodrill (1977).

Dodrill (1977) suggested a 10-month to two-year reproductive cycle for *C. acronotus*, however, I believe two separate populations with shorter gestation periods exist in the Western Atlantic. Evidence for this is as follows.

Mating occurs in North Carolina in August for females caught then exhibit scars or open wounds along the dorsal and flank areas of the body. There is no conceivable way such August-mated females could develop near term embryos of 49 to 51 cm TL by September or October, sizes encountered in June, unless those females had been mated elsewhere and subsequently emigrated into North Carolina waters. North Carolina's blacknose sharks mated in August thus yield the young subsequently pupped in the south the following spring or summer, a gestation period of nine months and shorter than estimated by Dodrill (1977). Capture of young is greatest in Florida and the Gulf of Mexico from May to November (Clark and von Schmidt, 1965; Branstetter, 1981). Castro (1983) noted the period of birth as April for Florida and May to early June in the Gulf of Mexico.

The other population of blacknose sharks mates in the Gulf of Mexico and along the east coast of Florida during the spring and summer previous to their appearance in North Carolina where they pup the young I capture in June to September (Table 3). The increased numbers of blacknose sharks caught in June and October in the Gulf of Mexico (Branstetter, 1981) strengthens the suggestion of southerly contribution by North Carolina sharks and their occurrence and capture elsewhere.

Thus, there seems to be constant exchange of blacknose sharks into and out of North Carolina, probably from Florida and the Gulf of Mexico (see also comment on annulus interpretation in relation to this aspect). Females captured in North Carolina in June as well as September are often carrying two to six near term specimens (see sizes of young Table 3). I cannot substantiate this exchange or migration through tag return data for no returns have occurred from the 664 fish tagged. This, however, is not

Table 3. Smallest (S) and Largest (L) (fork length) *C. arconotus* captured by month, sex, and year sampled.

Month		M		J		J		A		S		O	
Size		S	L	S	L	S	L	S	L	S	L	S	L
Year													
1973	♂			1001	1200							950	1300
	♀										1251	1050	
1974	♂			950	1150								
	♀									1110	1355		
1975	♂	902				925	1150	900	950				
	♀					950	1150			715	1200		
1976	♂			850	1100	750	1000			900		950	
	♀			900		780	1200	850	1150	1050	1100	1000	1050
1977	♂	740	1050	805	1000	955	1050	900	1400	950	1110	906	
	♀	740	1150	852	1200	740	1050	950	1200	960	1300	1050	1200
1978	♂	850	1050	850	1050	900	1000	800	1050	950	1300	900	
	♀	950		1000	1050	1000	1200	850	1150	740	1250		
1979	♂	1000	1050			556	1000	900	1000	900	1000		
	♀	1050	1150			850	1200	950	1150	950	1300		
1980	♂			950		800	1210	900	1100	900	950		
	♀				1150	950	1100	1000	1250	715	1267		
1981	♂			850	1000	1000		815	1050				
	♀			950	1170	1100	1300		1050		1150		
1982	♂	900	1050	850		755	1000	800	1050	800	1000	950	
	♀		1050		1000	850	1000	770	1250	814		950	1110

surprising for no active trawl or longline shark fisheries occur for *C. acronotus* throughout its range. Regional longline fisheries are also usually directed at other species and occur offshore of the coastal habitat preferred by *C. acronotus*. A few shark derbies result in the capture of some blacknose sharks but do little to resolve migratory patterns.

Catch per unit effort: More blacknose sharks were captured per longline set (2.23 total) or per 100 hooks (1.9, Table 4) in North Carolina than in Florida (Dodrill, 1977) or the Gulf of Mexico (Branstetter, 1981). Dodrill and Branstetter used a mixture of larger hooks, longline sets and rod and reel efforts, hence, their data were not exactly comparable but were used to illustrate that blacknose sharks contributed readily to the North Carolina catches and were abundant off Shackleford Banks. Since my fishing efforts spanned only part of the day; as opposed to Dodrill or Branstetter's, no reliable comparison could be made other than to say longline sets made in North Carolina early in the day yielded more sharks than did those near noon or in the early afternoon, which was a catch trend observed for all sharks by Branstetter. While Dodrill fished both day and night and found catches of blacknose sharks greatest between 0800-1600 hr and least between 0001-0800 hr, no night sets were made during my study as the area was heavily fished at night by the shrimp trawl fleet; such heavy boat congestion would have jeopardized the longline efforts.

I set a total of 33,457 hooks, with generally increasing units of effort each year except 1976, 1978 and 1981 (Table 4), during the 10 yr of sampling. Corresponding yearly increases in catches of blacknose sharks were not evident. Perhaps this relationship was influenced by the environmental factors mentioned earlier.

Catch/set was greatest on an early morning, ebb tide rather than on a flood tide. In general, sets during flood tides, regardless of time of day, yielded fewer sharks.

No apparent depth shift in catch occurred in sets set north-south regardless of time of day or tide. Catches were usually associated with a given depth each day. Usually 12 m depths were areas that yielded the highest catch per unit effort (CPUE), regardless of water temperature, salinity, season or tide. Likewise, higher catches usually were associated with one or other end of the line when set east-west. If the line was set in a north-south direction over increasing depths, catches at one depth level or another yielded more sharks rather than catches throughout all depths.

Age and Growth

Examination of stained vertebrae for rings (annuli) revealed that many of the vertebra possessed darkened and opaque areas often interspersed with thin stained rings. Because of the irregularity of the thin rings, they were not considered true rings (annuli), but rather false annuli deposited while the North Carolina-caught blacknose sharks were elsewhere (see earlier comments) or an artifact of stress to some unknown environmental or physiological feature. This could of course depend on my assumption that two breeding populations exist. Thus a blacknose shark in the Gulf of Mexico or in Florida, if it never

Table 4. Number of trips, total number of hooks, total catch, catch per set trip, and catch 100/hooks of blacknose sharks longlined 1973 through 1982 just south of Shackleford Banks, North Carolina compared to data from East coast of Florida (Dodrill 1977) and Gulf of Mexico (Branstetter 1981).

Year	Trips[1]	Total hooks	Catch/ caught	Catch/ set trip	Catch/ 100 hooks
1973	10	1600	27	1.35	0.017
1974	12	2466	8	0.34	0.003
1975	16	2784	58	1.82	0.021
1976	16	2696	40	1.25	0.015
1977	16	2938	138	4.22	0.047
1978	16	2434	73	2.28	0.025
1979	16	3284	76	2.38	0.023
1980	17	4798	122	3.59	0.025
1981	16	4290	31	0.97	0.007
1982	16	5667	91	2.85	0.016
Total	149	33457	644	2.23	0.019
Dodrill					
1977	330[2]	9754[3]	45	0.137	.0046
Branstetter					
1981	69[4]	6476[5]	34	0.49	.0053

1) two sets per trip, 10 year total 198 sets.
2) as days fished, see his Table 3.
3) as hook by rod and reel, see his Table 3. No time given per rod fished.
4) data for Table 2 and 3.
5) does not include varying daylight rod and reed efforts fished.

migrated to North Carolina, could exhibit only the expected regular stained-unstained ringed vertebral face. Lack of age determination data of blacknose sharks in the southern portion of their range precludes such confirmation. I, therefore, disregarded the thin rings evident on about 70% of the vertebrate examined and did not use them in age back calculations.

Plotting the focus to edge of the centrum distance versus shark length measurement indicated a linear relationship (Figure 3). Back calculations (Table 5) indicated that mean length at birth for males was 563 mm FL (693 mm TL). Even though the sample sizes for males back calculated for ages 1 and 6 were small, males were estimated to be 1,231 mm FL (1,536 mm TL) (Figure 4) at age 6. Females were back calculated to be 665

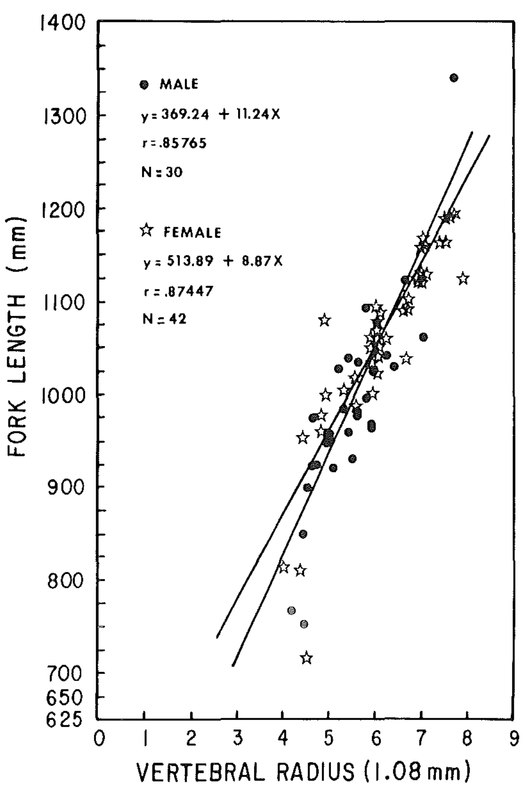

Figure 3. Vertebral radius - shark fork length relationships for male and female blacknose sharks caught in North Carolina.

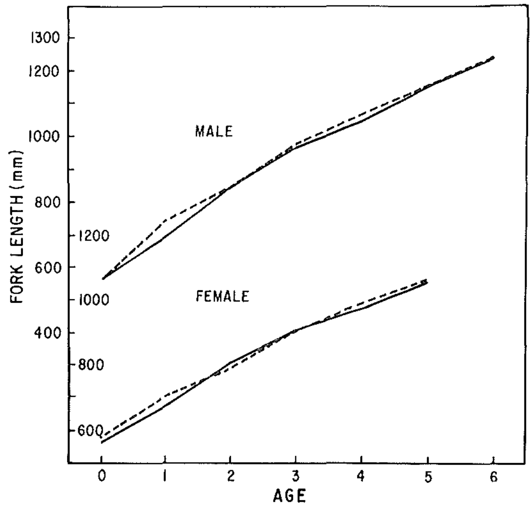

Figure 4. Actual (solid) and back (dashed) calculated fork lengths for male and female blacknose sharks captured in North Carolina. See Table 5 for sample sizes for each age studied. Outer scale for male data; inner for females.

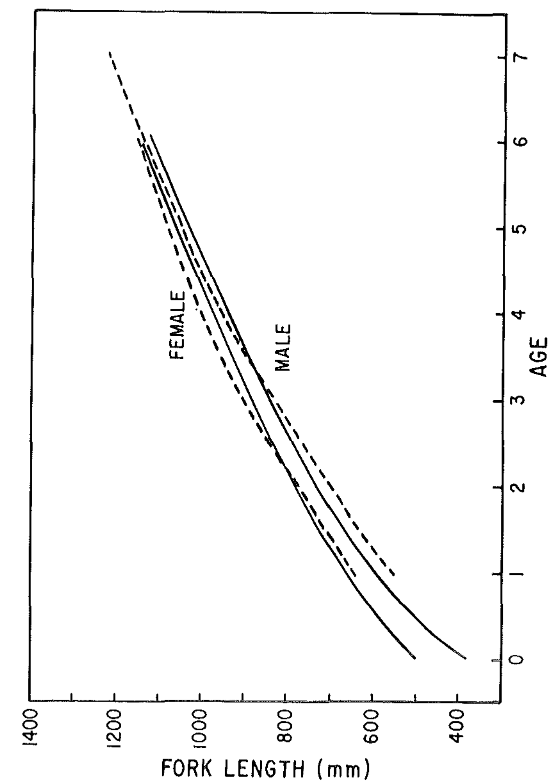

Figure 5. Back calculations and von Bertalanffy plots of male and female blacknose shark growth captured in North Carolina. See Table 5 for sample sizes for each age studied.

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Table 5. Back calculation of lengths (mm FL) of male (A) and female (B) blacknose sharks at core (O) and each successive age.

A (♂)

age	N	core (O)	1	2	3	4	5	6
1	3	567	746	855				
2	16	559	688	844	953			
3	10	571	705	853	973	1043		
6	1	548	660	862	974	1075	1153	1231
ave.	30	563	699	844	961	1046	1153	1231

B (♀)

age	N	core (O)	1	2	3	4	5
1	3	682	804	893			
2	9	657	761	889	979		
3	15	661	760	913	1004	1052	
5	15	670	781	907	1020	1095	1154
ave.	42	665	771	904	1004	1073	1154

mm FL (816 mm TL) at birth, somewhat smaller than the smallest free-living specimen captured at 715 mm FL (887 mm TL), yet an unrealistic size. Females at age 5 were calculated to be 1,154 mm FL (1,412 mm TL) (Table 5). Notice that because of the small sample size for age 1 females a distinct difference existed between observed and back calculated lengths (Figure 4).

Employing the von Bertalanffy growth formula, I was able to express male growth as $L_t = 1{,}887\ (1\text{-}e^{-0.117\ (t+2.01)})$; and female growth as $L_t = 1{,}650\ (1\text{-}e^{-0.138\ (t+2.68)})$ (Figure 4). Back calculation of fish length at each age agreed well for observed data for males whereas the data for females seemed to yield higher values than expected. The latter may again be a function of small age 0 or 1 sample size. Further, on the basis that the largest male captured was 1,400 mm FL (1,640 mm TL), its estimated age by the von Bertalanffy method would be 9.6 yr, while a 1,350 mm FL (1,540 mm TL) female would be 9.6 yr old. Females at 1,154 mm FL (1,312 mm TL), by linear regression, were calculated to be 5 yr old as opposed to 6 yr by the von Bertalanffy method. Whether the discrepancy is a matter of misreading the first ring, which I assumed was a false ring, remains unanswered at this time. Further studies with tetracycline marking (Gruber and Stout, in press) may resolve the real size at first ring formation, especially in females. Otherwise, the theoretical data readily fit the observed back calculated lengths if the thin false ring inside the first large dark colored ring is really the first true ring.

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